NIMS REFLECTANCE SPECTRA FOR THE ICY GALILEAN SATELLITES

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We present analysis of Galileo Mission NIMS (Near Infrared Mapping Spectrometer) reflectance spectra for the icy Galilean Satellites [1], emphasizing the interpretation of these spectra to determine the presence and identity of any non-ice components of the surface. Spectra have been analyzed so far for regions on Callisto, Ganymede and Europa, and more spectra are expected for all three icy satellites before this report is given. NIMS is providing up to 408-channel spectra, in steps of x2 (102, 204, 408 channels), over the spectral range 0.7 to 5.2 µm for spatial resolution elements varying from near one km to hundreds of kms. Analysis reveals high-quality spectra exhibiting the presence of water ice and non-water-ice spectral features, most not seen so far in groundbased telescopic data or in laboratory data libraries [1,2].

Water ice is present in most spectra, as shown by Earth-based telescope observations [3] and NIMS [1]. Preliminary radiative transfer models [2] indicate the amount of water ice percent in relation to the total surface composition is in some locations 0% for Callisto and 10% for Ganymede. The ice absorption shapes and position for λ near 0.98, 1.22, 1.48, 1.95 µm indicate the presence of hydrated minerals. Using the ratio of band depths for bands of differing absorption strengths, it is possible to determine that there is both more and finer grained ice toward the poles of Ganymede, Callisto and Europa.

Further, we see an unusual increase of water ice band depths and visible/NIR continuum brightness near limbs and terminators on at least Callisto and Europa and probably on Ganymede. This may be due to temporal thin frost layers near morning and evening terminators. Alternatively, at least on Callisto, we may be viewing preferentially near limbs and terminators the higher elevations, which have brighter and more water-rich material exposed due to mass wasting[4].

The strongest non-ice spectral feature is the very strong band near 2.8 µm, which appears on all icy satellites. This absorption is due to OH stretch in both water and hydrated (HOH and OH) minerals. Preliminary modeling indicates this feature is due almost entirely (Callisto) or mostly (Ganymede) to hydrated minerals. Non-ice spectral features (Figure 1), not seen before, include weak absorptions for Callisto near 3.88, 4.05, 4.25 and 4.57 µm. For Ganymede, only the 4.25 µm feature has been detected so far, and its strength is approximately half that for Callisto. No spectral features other than water ice and water of hydration have been unambiguously identified by us for Europa so far, partly because Europa is almost black longward of 2.75 µm, due to the large amount of water ice and perhaps other IR dark materials. The 4.25 µm band is the strongest of the weak bands discovered and varies in strength from 10 to 40% on Callisto and 0 to 25% on Ganymede. The maximum strengths of the other weak bands seen so far are: 5% (3.88), 12% (4.05), 12% (4.57).

These weak bands vary in strength with location in a way suggesting that a number of different materials are responsible. Candidate materials so far identified for the 4.25 µm absorption include hydrated minerals exhibiting various metal-OH minus OH or HOH combination bands, and CO_2, possibly in a clathrate, with amounts modeled to be 0.5wt% CO_2 on Callisto and 0.2wt% CO_2 on Ganymede on the average. The 4.25µm band spatial distributions include concentration near the equator on Ganymede and Callisto. Fine-grained frost is concentrated near the poles on both Ganymede and Callisto and may mask some of the non-ice absorptions.

Maps of non-ice band strengths indicate a correlation of band strength with geologic features, including both with fresh craters and with ring structures around large older craters (Figure 2) such as Asgard on Callisto. The 4.25 µm band strength is correlated with the brighter craters in many, but not all cases, and is high in some areas which are apparently without bright craters. The 4.05 µm band strength shows little correlation with bright craters, appears almost anti-correlated with the 4.25 µm band, and may be concentrated more on the leading side.

[1]Carlson, R. et al. (1996) Science Vol 274 pp. 385-388.

[2]McCord, TB *et al*. (1996) *Eos Trans* 77, No. 46, pp. F445., and McCord, T.B *et al*. (1996) *Bull. Amer. Astron. Soc*. 28, No. 3, pp. 1138.

[3] Calvin, W.M. *et al*. (1994), *JGR*, Vol. 100, pp. 19041-19048.

[4] Bender, K.C. et al. (1996), EOS Trans. AGU Vol. 77, pp F441.

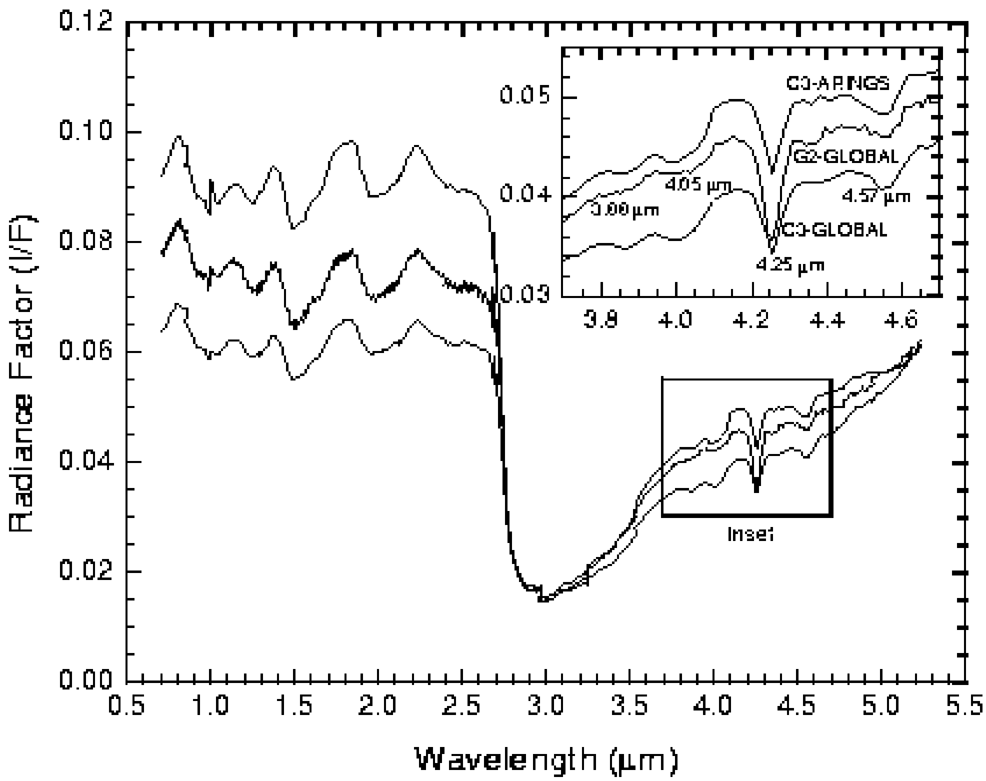

Figure 1: NIMS Reflectance spectra are shown for regions on Callisto. Note water-ice bands at approximately 1.22, 1.45, 1.95 µm, water-ice/water of hydration band near 3 µm, and the newly-discovered weak 3.88, 4.05, 4.25 and 4.57 µm bands (see insert).

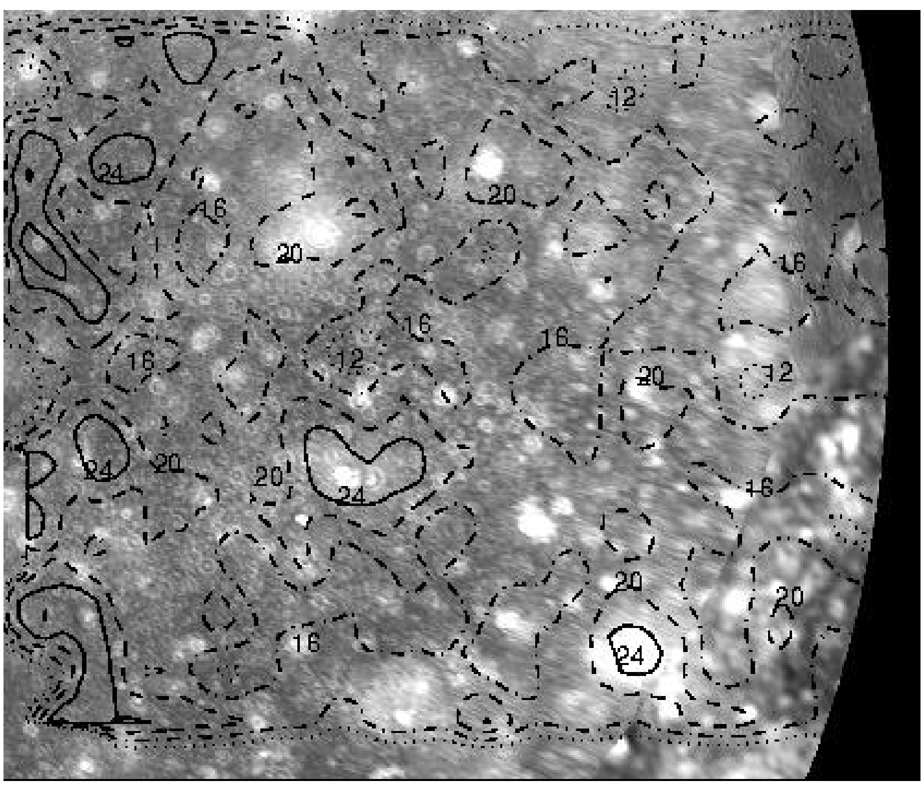

Figure 2: Voyager imaging system panchromatic mosaic image is shown for Callisto region approximately (-25 to +20 deg. lat., 120 to 190 deg. longs). Contours of the strength (in % of continuum) of the 4.25 µm absorption are shown as an overlay. Note the partial, but not complete, correlation with bright craters.